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# SOME RECENT DEVELOPMENTS IN COTTON RESEARCH AT THE SOUTHERN REGIONAL RESEARCH LABORATORY 1/ 2/

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The fineness, beauty, and utility of the cotton fiber have been recognized and desired by consumers for over 5,000 years. Yet cotton is not the oldest fiber in the world. About 50 centuries ago it was an obscure newcomer, appearing mysteriously in India to offer competition to the far more ancient fibers, silk and wool. The story of how cotton finally came to dominate the textiles of the modern world is old to everyone. The contemporary story of its threatened markets, after over a century of complacence, is also well known to this audience.

Some of the routes which scientific research is following in an effort to help cotton meet its present competitive situation will be indicated in my talk to you today. I start by expressing my conviction that hopefulness for cotton's future dominance of textiles will be warranted only if painstaking physical and chemical studies of the structure of the cotton fiber are made the basis for technological developments designed to so enhance the qualities of cotton that it can meet specific use requirements better or at least on a par with its competitors.

Although the Textile Research Institute has remained true to its commitment to impartiality among textile fibers, I do not know of any other research group that has been more sincere in putting forward the profoundly important economic implications for our nation of research aid to cotton. In the ten years preceding World War II, this Institute was among the pioneer research organizations to recognize the value of fundamental research on the physical and chemical properties of the fibers entering into textiles as a prerequisite to a much more advanced textile technology. I therefore consider it a unique opportunity to address this group; for my organization, the U. S. Southern Regional Research Laboratory, devotes large resources to research on every phase of developing greater usefulness of cotton.

1/ Report of a study in which certain phases were carried on under the Research and Marketing Act of 1946.
2/ Presented before the Annual Meeting of the Textile Institute, New York, New York, November 18-19, 1948.
3/ One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

A very great deal has been said in many places about the objectives of our research on cotton and now it is right that we be asked what we have done towards implementing these objectives. I think a few examples of what we have accomplished at the Southern Regional Research Laboratory will serve to answer this question, at least in part.

OBJECTIVES OF COTTON RESEARCH AT THE SOUTHERN REGIONAL RESEARCH LABORATORY

Given the over-all objective of maintaining, developing, or extending the usefulness of cotton, work on cotton lint at the Southern Regional Research Laboratory is of three general types. In the first line of work, fundamental knowledge is sought of the physical and chemical structure of the fiber, with the idea of establishing a relation between basic properties and product performance. A second line seeks the formulation of chemical finishes which will enhance the natural fine qualities of cotton and improve other qualities in which cotton is not so well developed; or seeks the chemical modification of cotton to create entirely new characteristics. The third line is mechanical processing research to develop new or improved machinery for more efficient and economical manufacture of high-quality cotton yarns and fabrics.

In all of these investigations, we constantly evaluate our developments for use by industry, constantly confer with industry, and in many other ways cooperate with cotton manufacturers, from whom in return we receive valuable assistance in carrying our experimental products and processes through the stage of commercial testing. We know that such collaboration is essential for the ultimate realization of our objectives.

COTTON TIRE CORD

There is no other field in which all the phases of the problem facing cotton are better typified than in the tire cord field. More cotton is consumed in tire cord than in any other single use. More competition has been met from rayon in this market than in any other. More of the fundamental properties of cotton are involved in tire cord performance. And so, improvement of cotton tire cord through research at the Southern Regional Laboratory is a good example of our contributions to the development of better cotton products. Our tire cord studies range from measurement and evaluation of individual properties through the production of experimental cords for wheel testing by tire producers, including also efforts to improve the equipment used by industry in manufacturing tire cord. I shall discuss briefly a few of these developments.

Fundamental Investigations

We are fully aware in our tire cord research that one of the greatest opportunities for real improvement in the quality of cotton cords lies in the field of fundamental physical and chemical studies of the inherent properties of the cord. With this in mind we have conducted varied investigations of the interrelations of individual properties with each other and of their influence upon the final performance of the cords in tires. Some of the more important studies have dealt with the relationship of moisture, heat, and cord construction on the tensile and elastic properties of the cords. I have selected a few of these for discussion.

Varied studies of hysteresis, elastic modulus, and of elongation growth of cotton tire cord over a wide range of moistures and temperatures have brought out a number of significant facts. In general, moisture content over the ordinary ranges in our experiments had a much greater effect on elastic properties than did temperature up to 145° C. With the higher moisture contents, hysteresis and growth rate increased, and elastic modulus decreased. (With increasing temperature, hysteresis increased slightly but persistently, and elastic modulus increased or remained unchanged.) The results obtained in these and similar studies have provided better criteria of the desirable properties of a tire cord in terms of performance. Low values for hysteresis, elastic modulus and usually for growth rate are desirable.

We have studied heat as a deteriorating agent for cotton cords, both alone and in tires, and have compared this effect in rayon cords, using measures of fluidity in cuprammonium dispersion, breaking strength, and elongation over a wide range of temperatures. Our results showed that prolonged heating of both cotton and rayon cords caused marked deterioration in a number of physical and mechanical properties, and that embedding in rubber definitely reduced the rate of degradation. Specifically, loss of strength occurred in all cords except in those heated only for short periods at relatively low temperatures. In every case, the extent of deterioration was progressive with time and temperature of heating. The protection afforded the cords vulcanized into the rubber tire carcass was presumably due to a reduction in the amount of atmospheric oxidation. Coating with latex to improve adhesion did not provide any protection, and calendering the skin stock only a little. In general, cotton cords showed larger retention of strength than rayon cords--strength for cotton after 256 hours at 120° C. varied from 72 to 90 percent of the original and for rayon from 45 to 80 percent.

Extensive studies have been made of the influence of cord construction on cord properties. Cotton tire cord is a complex mechanical structure consisting of a number of single yarns twisted together to form plied yarns (or cables), and a number of these cables twisted together to form the cord. It is fairly common commercial practice to use 4 single yarns in the cable and 3 cables in the cord. It was found that variation in the number of single yarns from 5 to 3 and in the number of cables from 3 to 2 resulted in very little variation in the strength of the cords. However, the flex fatigue life, as measured on two Southern Laboratory-developed flex machines, was decidedly greater for the 3-cable than for the 2-cable cord. With regard to elastic properties, the 2-cable constructions showed a lower hysteresis loss and a slightly higher elastic modulus. The amount of twist imparted to each component of the cord has an important bearing on the inherent strength, elongation, and fatigue resistance of the cord as a whole. For example, it was discovered that a lower than normal twist in the singles yarn resulted in a cord of longer fatigue life. A group of experimental tires made with a cord having less than the conventional twist in the singles yarn, had exceptionally good fatigue life in indoor wheel tests, run at above normal load, averaging 27 percent more mileage than the group of tires made with a cord having the normal twist.

## Chemical Treatments

High strength at elevated temperatures is desirable, particularly for tires in heavy duty service in hot weather. At the Southern Laboratory we have developed a cotton tire cord having substantially improved heat resistance by a practical modification of the mercerization process. The treatment is applied under specified conditions preferably to yarns of a suitable special twist before their manufacture into cords.

Other research on chemical finishing to improve cotton tire cords has included an evaluation of lubricating treatments in respect to flexure endurance. We found that lubrication increased flex life, on our laboratory flexing machine, 8 to 10 times at temperatures ranging from 86° to 248° F., without greatly affecting the cord otherwise. It is planned to evaluate the performance of lubricated cords in tires with indoor wheel tests.

Machinery Development

Another line of current tire cord research is the development of machines to produce cord having more precisely the qualities needed in service or of machines to speed up manufacture of tires or tire cord. Before entering upon this subject, I want to emphasize that in this division of our research we work very closely with tire manufacturers, largely through an advisory group of seven representatives of the major tire companies.

Particularly desirable in a tire cord are uniform strength and a uniform amount of elongation under different loads. Rayon tire cords are better in this respect than cotton, and so our technologists have devoted considerable attention to the problem of improving the uniformity of cotton cords. In one phase of this work, they applied a new principle of stretching and developed a device which subjects the cord to constant tension during stretching rather than to the constant percentage of stretch usually applied. The device permits a variable rate of stretching. It operates faster than other stretching machines and, above all, produces a more uniformly strong and more uniformly elongating cord. Manufacturers of cotton tire cords have shown great interest in this new machine and several are evaluating its possibilities in commercial operation.

Research improvements in tire cords can be finally evaluated only by service tests in experimental tires. In commercial tire manufacture, long yardages of cord fabric are required for loading the dipping, drying, and calendering machines, so that in the manufacture of one or two experimental tires more than a hundred pounds of cord are used. Several large rubber companies have been cutting down development costs and production time by using a special machine for building plies from small quantities of cords, which permits bypassing of the regular dipping, drying, and calendering machines. On the basis of information obtained from one of these companies, Southern Laboratory engineers have designed and constructed a ply-building machine and incorporated a number of features which permit more efficient and faster operation. The cord is dipped, dried, and formed into a ply with rubber in one operation. Other features are that the quantity of experimental cord required is only slightly more than that contained in the experimental tires--the ply can be built from a single spool of cord, instead of more than 1,000, as required for processing in the usual manner. This machine is now operating successfully at a plant in Mississippi and is producing tires for evaluation of our laboratory research.

PRESERVATION OF COTTON AGAINST DEGRADATION BY ROTTING AND WEATHERING

I mentioned awhile ago that one broad field of our research deals with the application of chemical finishes or modifying treatments to cotton so as to improve its present properties or to create entirely new properties. There are two major qualities in which cotton is far from giving entire satisfaction to consumers; namely, its resistance to rotting and its resistance to weather. Yet because of other properties, cotton is desirable in uses which subject it to degradation from those causes. We at the Southern Regional Research Laboratory have therefore given attention to both of these problems. I shall discuss first our investigations in the field of rotproofing cotton textiles.

## Rotproofing Cotton

There are many known treatments which improve cotton's resistance to rot, by impregnating it with various chemicals. These nearly all have the disadvantage of imparting qualities to the finished product which limit its usefulness--for instance, they produce objectionable color, odor, or stickiness, or render the material poisonous. An entirely different type of treatment is one which modifies the fiber itself and produces the desired effect by a change in the composition of the cellulose. A new compound is formed which is extremely resistant to rotting.

The treatment which our chemists have developed is accomplished by partial acetylation. This involves the conversion of cotton cellulose in the form of fiber, yarn, or cloth directly by chemical reaction, in a bath containing acetic anhydride, glacial acetic acid, and a catalyst, to a modified cellulose in which some of the hydroxyl groups are replaced by acetic acid radicals, without loss of fibrous or other textile properties. Thus, part of the cellulose in the cotton is converted into cellulose acetate, a substance which apparently does not tempt the appetites of rot-producing organisms. Beside its advantage over other rotproofing treatments in enabling the fiber to retain the form and appearance of plain cotton, the treatment does not produce any of the objectionable odor or appearance of the usual treatments. A sufficient degree of acetylation (20-30% of acetyl) produces virtually a new fiber with new properties, which is adaptable to additional utilizations. Our present laboratory investigations are centered on simplifying and speeding up the process. This is being approached by attempts to apply the treatment by continuous methods instead of by the batch methods now used.

Application of the partial acetylation process to cotton was first tried in England; but we were the first laboratory in the United States to explore thoroughly its rotproofing possibilities. Undertaking this phase of cotton improvement during wartime, we first applied acetylation to cotton sandbags of the type used in military operations. Tests of the treated bags piled in stacks on the ground in New Orleans demonstrated the superior resistance to rot of partially acetylated cotton in contact with the destructive forces in the soil. The surface fabrics of the bags at the bottom of piled stacks fully exposed to weather for 2 years retained from 35 to 40 percent of their breaking strengths. Surface fabrics of bags at the top of the stacks retained 35 to 100 percent in contrast to complete deterioration of untreated bags in one-fourth the time. The amount of resistance to rotting by acetylated materials depends somewhat upon the variables of the method, as well as the degree of acetylation.

Samples of acetylated materials are continually sent out from the pilot plant of the Southern Laboratory for industrial trials. One use which has appeared is in bags of the type used to carry water-softening agents. Untreated cotton already possesses high abrasion and tear resistance, easy and rapid drainage, and good filtering action, qualities needed in this use; but water-softening bags must above all be rot- and mildew-resistant, nontoxic, and must not affect taste. Cotton modified by partial acetylation meets all these requirements. Treated cotton bags have lasted a year, in contrast to one month or even a week for untreated bags. An Indiana manufacturer, aided by Southern Laboratory engineers, has started a small commercial production of these bags. The fishing industry which is trying acetylated cotton cord, rope, and gill nets in service in various waters, reports favorably. A trial of acetylated cotton linings in men's shoes is in its second year with encouraging results reported. One company has evaluated acetylated shoe lining for abrasion resistance and reports that it may have some advantage over ordinary cotton in this property. Another industrial application of acetylated cotton is as a re-enforcing material in plastic laminates in which its good resistance to heat and electricity and its good dimensional stability are of importance.

The industrial trials of partially acetylated cotton goods demonstrate once more the value of research developments to industry and the corresponding value to research organizations of the cooperation of manufacturers.

Weatherproofing Cotton

In the weatherproofing field, I believe that I can say unhesitatingly that our research has made a valuable contribution to fundamental knowledge of the mechanism by which cellulose breaks down during exposure to weather and of the nature of the influence of chemical treatment on the degradation suffered. The action of weather on cotton is extremely complex and variable. In dry places, sunlight is the principal destructive force, whereas in warm, moist climates mildew and rot may be a contributing or a major cause of failure. In fact, chemical treatments which are effective rot-proofing agents sometimes actually promote decomposition due to weather.

Patterns of degradation. In 1946 we assembled and interpreted the data which we had collected over a period of five years in tests of representative cotton fabrics, some untreated and some chemically treated, exposed outside on racks in the warm, damp climate of New Orleans. Compounds evaluated included fungicides, water-repellants and ultraviolet-screening pigments. The changes in breaking strength and fluidity of the various samples were correlated and showed a definite relation. The value of this work was the establishment of patterns of weathering degradation for different types of fabrics which are proving useful in the formulation of protective finishes.

Degradation by light. In our studies at the Southern Laboratory the effect of sunlight was isolated from the other degrading elements of weather. Use was made of a special rotating cabinet which excludes wind, rain, dust, and micro-organisms and exposes the cotton fabric samples continuously throughout the day to the rays of the sun. It exposes samples behind six glass windows, each one having a different color and therefore transmitting a different fraction of sunlight. In this cabinet samples were exposed to the energy of five different spectral regions as well as to total solar radiation. From the data collected on the radiant energy incident upon each sample and on the chemical and physical evidences of deterioration, it appeared that the energy from some parts of the spectrum (the ultraviolet rays) is more damaging than that from others, but that rays of certain wave lengths may interact in such a manner as to reduce the net degrading effect of their combined incident energy. Similar data have been obtained with the use of a carbon arc lamp as a source of radiation and Corning glass filters as a means of obtaining certain selected spectral regions of incident energy.

Army ducks and shade cloth. Current weatherproofing research is being directed towards the formulation of protective finishes for army awning ducks and tobacco shade cloth, two uses in which good resistance to sunlight is particularly desirable.

In research on protective finishes for cotton ducks, the following types of treatment have been tested: clear resins alone, mineral pigments alone, and combinations of resins and pigments. The tests were made at four geographical locations. Plain urea formaldehyde resin gave definite protection to undyed or solid-dyed fabric and a combined resin-pigment treatment (urea formaldehyde-lead chromate) gave even greater protection. With this resin-pigment combination less than five percent of strength was lost after a year's exposure, against the 50 percent lost by untreated fabrics. In the treatment of colored, striped awning ducks, the treatment must not introduce an interfering color, and only clear, light-absorbing resins have been tried. The effectiveness of urea-formaldehyde resin in this type of treatment was indicated and the studies are continuing.

Research on tobacco shade cloth was made a phase of weatherproofing work at the specific request of a group of Florida tobacco growers. About 60 million yards of tobacco shade cloth is annually produced from cotton. If tobacco growers can obtain an economical treatment to prolong the service life of the cloth, undoubtedly larger acreages of tobacco would be shade-grown, thereby providing an extension of cotton's use in this market.

It was known from our previous work that the light waves which do the damage to cotton can be absorbed by various mineral pigments and film-forming resins. Since the finishing of tobacco shade cloth presents certain processing difficulties, relatively simple pigment or pigment-resin treatments were tried. Precipitation of lead chromate in the fabric appeared the most effective in tests which used about 10,000 yards of cloth in the 1948 season in Florida tobacco fields--lead-chromate-treated cloth lost only 25 percent of its strength in contrast to 70 percent by untreated cloth. Tests of much larger yardages of the treated cloth will be conducted in Florida next season. This work is another illustration of the benefit to be derived together by scientists and agricultural groups in cooperative experiments.

## WATER-RESISTANT COTTON BY SELF-SEALING THROUGH SWELLING

Many of the outdoor uses of cotton take place under conditions where resistance to water is of the first importance. Improvement in this quality will be a major need if cotton continues to be faced with its present competition. This aim is therefore being approached in current work at the Southern Regional Laboratory.

Impermeability of cotton fabrics to the passage of water is being sought largely by virtue of a self-sealing effect upon swelling in water. Three lines of approach are being studied: (1) Through the selection of cotton varieties best adapted to self-sealing; and/or (2) through treatment of the yarns before weaving with various insoluble "swellable" finishing agents to induce a greater amount of swelling; and/or (3) use of a more densely woven cloth -- one with more filling threads per inch than conventional weaves.

The present research is the outgrowth of a successful wartime project in which we utilized the swelling property of cellulose to produce a cotton fabric sufficiently watertight for the manufacture of rubberless cotton firehose (of the sort used commonly in emergency installations). In the earlier work the self-sealing effect upon swelling the fibers in water, serving to close up the minute spaces between the fibers in the yarns, was augmented by the addition of a swellable finishing agent before weaving, hydroxyethylcellulose being found the most effective. Because of the satisfactory performance of the all-cotton firehose, the U. S. Quartermaster Corps requested continuation of the work to develop light-weight, water-resistant fabrics for outdoor use. This was approached through a search for cotton varieties more suitable than others for utilization of self-sealing by swelling -- that is, those having the greatest capacity upon wetting to close up the spaces between fibers and thus render the yarns, or the cloth, more resistant to penetration by water. In early work, the discovery was made that not only might differences in the swelling property be expected from variety to variety but that the immature differed from the mature fibers of the same variety. This was revealed by use of a specially designed apparatus that provides a measure of the quantity of water which, under constant pressure, will seep through a weighed bundle of yarn or of loose fiber, tightly packed into an orifice. By means of this orifice test it was demonstrated that seepage of water through bundles of equal weights of mature and immature fibers from any variety of cotton was from 3 to 7 times greater for the mature fibers.

It is interesting, for comparison, to look at results we have obtained in microscopical measurements on cross sections of cotton fibers by a special technique developed for evaluating the moisture swelling capacities of different cotton varieties. This microscopical technique showed that in most of the samples investigated, the fibers, whether thick-or thin-walled, swelled over approximately the same range from the dry to the saturated state, about 20 to 30 percent. In one Empire cotton sample the thin-walled fibers swelled the minimum and the thick-walled the maximum amount. If these results are considered in conjunction with the reverse results of the orifice test, it is indicated that swelling is not the only important factor influencing the orifice test-- that fiber shape and size may greatly outweigh the influence attributable to differences in the absolute swelling for evaluation of cotton varieties for the production of water-resistant fabrics.

In making application of these findings, we have woven fabrics, using conventional constructions, from yarns which were indicated by orifice tests as having a good degree of impermeability. We have subsequently applied a water-repellent agent; or we have, before weaving, added highly swellable finishing agents to the yarns, such as hydroxyethyl cellulose, as used in the production of our unlined cotton firehose. In some cases, the treated yarns were woven into fabrics of an unconventional (extra-dense) construction by the use of a special loom attachment, developed in our laboratory. In preliminary tests, fabrics woven from yarns containing immature fibers have shown distinctly superior water resistance as compared to fabrics of identical construction from mature fibers. This development is expected to be of identical construction from mature fibers. This development is expected to be of considerable importance as it may provide a new outlet for immature or thin-walled cottons, now considered inferior for most uses.

I might mention, parenthetically, that in the microscopical studies of fiber cross-sectional swelling we made use of our special dye technique which differentiates between mature and immature fibers by cross-dyeing of the fibers with red and green dyes in the same bath. I believe that this audience is already familiar with this test, since the details have been published.

DEVELOPMENT OF NEW PROPERTIES THROUGH CHEMICAL MODIFICATION

The improvement of individual properties of cotton fiber are sought through the introduction of specific chemical groups into the cellulose molecule to replace or to combine with a number of the hydroxyl groups present. The conversion of part of the cellulose in cotton into the rotproofing compound, cellulose acetate, mentioned earlier, is one example of this. In the same manner, other properties of cotton have been improved through the formation of cellulose derivatives.

The introduction of amino groups into the cellulose molecule has produced a type of cotton which has an affinity for acid wool dyes, in contrast to ordinary cotton. Moreover, metallic elements added to aminized cotton give rot resistance; addition of organic groups gives water repellency; and there are other possibilities for further modification. Cotton may be aminized in the form of fiber, yarn, or fabric by allowing 2-aminoethylsulfuric acid to react with the cellulose in a strongly alkaline solution, followed by heating and washing. Breaking strength is not appreciably affected. The use of aminized cotton as an anion exchanger is being investigated.

Cotton fabric that absorbs water at a much faster rate than ordinary cotton has been obtained by an optimum procedure worked out for the formation of carboxymethyl cellulose. Carboxymethyl groups are introduced by treating yarn or cloth with alkali and small amounts of chloracetic acid. The reaction takes place without loss of fibrous properties and very little loss of strength. The treatment increases water absorbency and definitely speeds up the rate at which the water is absorbed. This property should be of value in such fields of utility as the towel industry.

It is of interest in this connection to refer to another well publicized technique which originated at our Laboratory, namely, the method which we have developed for measuring the rate of water absorption of cotton fabrics, and which a cooperating finishing company has now adapted to use with toweling.

Methanolysis of cotton cellulose in the presence of anhydrous acid produces a new type of short-chain cellulose molecule which is resistant to further action of strong alkalies.

The phosphorylation of cotton cellulose, originally accomplished as part of a wartime project which successfully produced flameproofed cotton, has been carried out by a treatment combining the application of heat with treatment by urea and phosphoric acid. Cellulose phosphate has also been prepared by using phosphorous oxychloride in the presence of pyridine. It has been demonstrated that phosphorylated cotton is a good cation exchanger.

COTTON PROCESSING RESEARCH

In the experimental cotton mill at the Southern Laboratory attention is constantly given to the opportunities for getting more uniform cotton products at every stage of production--from the time the matted lint enters the opening machine through all the steps of processing into yarns and fabrics. Improvements in the uniformity of cotton yarn, cords, and fabrics obviously would raise their quality and add to the serviceability of the finished product. Also, greater uniformity at the various stages of the manufacturing processes, by increasing production efficiency and reducing costs, would place cotton products in a stronger competitive position.

A series of drafting studies was conducted on several varieties of cotton of different staple lengths with a high-draft, or dual-zone, type of frame. The results showed that substantial improvements in uniformity can be secured with long, fine-fibered cottons as well as with short, coarse varieties by a better proportionment of drafts between the two zones. The immediately significant development of this work is a new draft guide to replace the conventionally used guide with this high-draft system whose use substantially improves the uniformity of the roving, reducing the strength variation in the subsequent singles yarn by about 50 percent. In another series of drafting studies we have found that while increases in draft on the drawing and roving frames do not affect materially the strength or grade of a coarse yarn, increases during spinning result in significantly lower skein strength, although they have little or no effect on the grade of the yarn.

The growing substitution of machine picking for handpicking of cotton has made imperative the development of more efficient equipment for cleaning ginned cotton in the textile mill. As a step towards this, we are attempting to establish some fundamental principles of cleaning. We have started with studies on the characteristic adherence of cotton fibers to trash and the electrostatic potential of the many types of trash particles--fuzz, twigs, sand, dirt, bits of stalk, and especially the leaf material which is particularly hard to remove. In the course of work on this problem, we have developed an improved cotton opening machine which fluffs up matted lumps of cotton into small, soft tufts to prepare them for subsequent cleaning. So far the indications are that the increased fluffiness is achieved without damage to the fibers. The design is flexible enough for use in getting information of research interest on each lot of cotton. Actually, trash removal is only incidental to the real function of the machine--the more efficient opening up of the matted cotton.

Another development in our mechanical processing investigations is a radical type of cotton slashing machine which we have recently designed and constructed for use in experimental slashing. The new machine dries the yarns by incandescent gas burners in an infra-red, hot-air oven, in contrast to the steam-heated drums used in conventional slashing. Another contrast is that our slasher provides control of rate of heating, and offers better control of mechanical variables. This equipment gives promise of aiding in research on the factors which influence the final quality of slashed products. It is being evaluated in our laboratory and its full capabilities have not yet been determined.

IN CONCLUSION

I close with the thought that these typical research activities at the Southern Regional Research Laboratory may serve to indicate the profitableness to cotton of the quest for basic data concerning the character of the cotton fiber. Furthermore, I believe that they emphasize the role that can be played by scientists in helping cotton keep pace with the technological advances made by other fiber industries. Although I have limited my discussion to developments within my own organization, these are certainly representative of the many investigations being conducted by an encouraging number of other institutions engaged in research on cotton. Finally, they demonstrate significantly the mutual advantages to be gained through cooperation by science, agriculture, and industry.